IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:		Atty. Docket No.:	006020.00011
Philip Victor HARMAN			
Serial No.:	09/921,649	Group Art Unit:	Unknown
Filed:	August 3, 2001	Examiner:	Unknown
For:	IMAGE CONVERSION AND ENCODING TECHNIQUE		

CLAIM FOR PRIORITY UNDER 35 U.S.C. §119

Commissioner for Patents
Washington, D. C. 20231

Sir:

The benefit of the filing date of the following prior foreign application is hereby requested for the above-identified application and the priority provided under 35 U.S.C. §119 is hereby claimed: (a certified copy of each foreign application is enclosed herewith)

Country	Application Number	Date of Filing (mm-dd-yyyy)
Australia	PQ9222	4 August 2000
Australia	PR2757	29 January 2001

It is requested that the file of this application be marked to indicate that the requirements of 35 U.S.C. §119 have been fulfilled and that the Patent and Trademark Office kindly acknowledge receipt of these documents.

Respectfully submitted,

BANNER & WITCOFF, LTD.

Dated: December 3, 2001

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AUSTRALIA

Patent Office
Canberra

I, GAYE TURNER, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PQ 9222 for a patent by DYNAMIC DIGITAL DEPTH RESEARCH PTY LTD filed on 04 August 2000.

CERTIFIED COPY OF PRIORITY DOCUMENT

WITNESS my hand this
Fourteenth day of August 2001

Turner.

GAYE TURNER
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Patents Act 1990

ORIGINAL

PROVISIONAL SPECIFICATION

IMAGE CONVERSION AND ENCODING TECHNIQUES

The invention is described in the following statement:

IMAGE CONVERSION AND ENCODING TECHNIQUES

FIELD OF INVENTION

The present invention is generally directed towards a technique for converting 2D images, that have been formed from a layered source, into 3D. It is also an objective of the invention to enable the resulting images to be stored and transmitted in a 2D compatible format and the images converted into 3D at the viewing location either prior to viewing or in real time.

BACKGROUND

The applicants have previously described in PCT/AU96/00820, a method of producing left and right eye images for a stereoscopic display from an original 2D image including the steps of:

a. identifying at least one object within the original image;

b. outlining each object;

c. defining a depth characteristic for each object; and

d. respectively displacing selected areas of each object by a determined amount in a lateral direction as a function of the depth characteristic of each object, to form two stretched images for viewing by the left and right eyes of the viewer.

These steps can be individually and collectively referred to as Dynamic Depth Cueing or DDC.

Additionally, the Applicants have previously described in PCT/AU98/0155 in one aspect a method of encoding a depth map including the steps of

a. allocating an object number to an object

b. allocating the object with a depth; and

c. defining the object outline

The object outline may be defined by a series of co-ordinates, and/or curves.

In another aspect the previous invention disclosed the use of curves to generate an outline of an object in a 2D to 3D conversion process.

In a further aspect the previous invention disclosed the use of curves to define an object in a 2D to 3D conversion process.

In a further aspect the previous invention disclosed a method of transmission of depth map information wherein the information is included in the Vertical Blanking Interval or MPEG data stream.

In a further aspect the previous invention disclosed the use of generic libraries to assist in the 2D to 3D conversion process.

Additionally, the applicants have previously described in PCT/AU00/00700 a method of encoding a depth map including:

a. identifying and outlining an object in an image;

b. allocating an object identification symbol to an object;

c. using the allocated object symbol to represent the shape of the object;

d. allocating the object with a depth;

e. compressing the information representing the object and its depth;

f. transmitting and/ or storing this information; and

g. decompressing the information.

Additionally this application disclosed a method of encoding a depth map including:

a. Identifying and outlining an object within an image;

b. allocating an object identification symbol to the object;

c. defining the object by drawing a plurality of lines across the image, and determining the start and finish positions of each said line, wherein a new line is commenced each time an object boundary is reached; and

d. allocating the object with a depth.

In PCT/AU96/00820 a number of techniques for producing DDC data for live broadcasting were disclosed. These included, although were not limited to;

Determining the distance of objects from a camera using variable focus techniques; and

The use of two cameras and an autocorrelator to determine the distance of objects from a camera.

In effect, these techniques described what has now become generally referred to as the production of a depth map, where each object in a scene is allocated a unique attribute (usually a shade of grey) depending upon the relative, or absolute, distance from the object to a reference point e.g. the camera lens.

The Applicants have previously disclosed how such depth maps may be compressed and included in 2D images to enable these DDC encoded image to be subsequently converted to a stereoscopic image.

Additionally, the applicants have previously described in PQ4166 a method that takes an existing depth map and represents it in terms of curves and ramp functions including:

a. Applying a curve to the outline of an object within the depth map;

b. Representing the continuous depth value within the outline with a ramp function; and

c. Encoding and compressing the data representing the curve and depth function

What has not been previously disclosed is a process that takes an existing 2D image that is comprised of a layered source, allocates a depth to each object on each layer and convert the image into 3D.

OBJECTIVE OF THE INVENTION

It is an objective of the present invention to provide a relatively simple technique for converting 2D images, that have been formed from a layered source, into 3D. It is also an objective of the invention to enable the resulting images to be stored and transmitted in a 2D compatible format and the images converted into 3D at the viewing location, either prior to viewing or in real time. It is proposed that 2D compatibility will be provided by applying the previously disclosed DDC techniques.

SUMMARY OF THE INVENTION

With the above objective in mind, the present invention provides in one aspect a method of converting 2D images from a layered source into 3D for a stereoscopic display requiring a left and right eye image, or a 2D image and an associated depth map or multiple images and includes the steps of:

defining a depth characteristic for each object on each layer, and

respectively displacing each object on each layer by a determined amount in a lateral direction as a function of the depth characteristic of each layer; and

including the information defining the depth characteristic for each object on each layer within the original 2D image such that the image may be viewed in

its original 2D form or subsequently converted into a format suitable for viewing stereoscopically.

BRIEF DESCRIPTION OF THE DRAWINGS

To provide a better understanding of the present invention, reference is made to the accompanying drawings which illustrate a preferred embodiment of the present invention.

IN THE DRAWINGS

Figure 1 shows a layered 2D image.

Figure 2 shows how the composite image in Figure 1 is composed of objects existing on separate layers.

Figure 3 shows how left and right eye images are formed.

DETAILED DESCRIPTION OF THE INVENTION

In the preferred embodiment, the conversion technique includes the following steps:

IDENTIFY EACH OBJECT ON EACH LAYER AND ASSIGN A DEPTH CHARACTERISTIC TO EACH OBJECT

The process to be described is intended to be applied to 2D images that are derived from a layered source. Such images include, but are not limited to, cartoons, MPEG video sequences (in particular video images processed using MPEG4 where each object has been assigned a Video Object Plane) and Multimedia images intended for transmission via the Internet, for example images presented in Macromedia "Flash" format.

Such a layered 2D image is shown in Figure 1. Figure 2 illustrates how the composite image in Figure 1 is composed of objects existing on separate layers and consolidated so as to form a single image. It will be appreciated by those skilled in the art that the separate layers forming the composite image may also be represented in a digital or video format. In particular it should be noted that the objects on such layers may be represented in a vector format.

Where more that one object is present on a specific layer it may be desirable to further segment the objects into additional layers to enhance the 3D effect.

In the preferred embodiment, each layer, and object within the layer, is assigned an identifier. In addition, each object is assigned a depth characteristic in the manner previously disclosed in application PCT/AU98/0155 that is hereby included by reference.

The general format of the object definition is therefore:

<layer identifier><object identifier><depth characteristic>

where the identifier can be any alpha numeric identifier and the depth characteristic is as previously disclosed.

It is an intention of this invention to disclose the addition of a depth characteristic identifier to existing layer based image storage and transmission protocols that may already identify objects within an image by other means.

In the simplest implementation the layer identifier may be used as a direct, or referred, reference to the object depth.

For example purposes only, consider a 2D image comprising 4 layers with each layer containing a single object. The layers may be numbered 1 to 4 and ordered such that, when displayed stereoscopically, the object on layer 1 appears closest to the viewer, the object on layer 2 appears behind the object on layer 1 etc such that the object on layer 4 appears furthest from the viewer. It will be obvious to those skilled in the art that this sequence could be reversed i.e. layer 4 could contain an object that is closer to the viewer and layer 1 an object furthest from the viewer or a non sequential depth or non linear representations applied.

This simple implementation has the disadvantage that should additional layers be introduced or removed during the 2D sequence then the overall depth of the image may vary between scenes. The general form of the object definition overcomes this limitation by separating the identifiers relating to object depth and layer.

LATERALLY DISPLACE EACH LAYER

It has been disclosed in the prior art that a stereoscopic image can be created by copying an object in a 2D image, laterally displacing it, and replacing the displaced object in a copy of the original 2D image so as to form a stereo pair. The prior art teaches that the amount of lateral displacement, and the

relative direction, determines how far away from the viewer the object appears when viewed stereoscopically.

It has also been disclosed in the prior art how a stereo pair can be created by cutting an object out of a 2D image, laterally shifting it and pasting it back into a copy of the original image. This creates a hole in the original 2D image which is undesirable. The applicant has previously disclosed in PCT/AU96/00820 an alternative method of creating a stereoscopic image from a 2D source by stretching objects in the 2D image that overcomes the limitations of the prior art.

For purpose of explanation only it is assumed that the 2D image is composed of a number of objects that exist on separate layers. It is also assumed that the 2D image is to be converted to 3D and displayed on a stereoscopic display that requires separate left and right eye images. The layers are sequenced such that the object on layer 1 is required to be seen closest to the viewer when converted into a stereoscopic image and the object on layer n furthest from the viewer.

Also, for purpose of explanation only, it is also assumed that the object depth is equal to, or a function of, the layer number. It is also assumed that the nearest object i.e. layer 1, will have zero parallax on the stereoscopic viewing device and that all other objects on sequential layers will appear behind successive objects.

In order to produce the left eye image sequence a copy of layer 1 of the 2D image is made. A copy of layer 2 is then made and placed below layer 1 with a lateral shift to the left. The amount of lateral shift is determined so as to produce an aesthetically pleasing stereoscopic effect or in compliance with some previously agreed standard, convention or instruction. Copies of subsequent layers are made in a similar manner, each with the same lateral shift as the previous layer or an increasing lateral shift as each layer is added.

In order to produce the right eye image sequence a copy of layer 1 of the 2D image is made. A copy of layer 2 is then made and placed below layer 1 with a lateral shift to the right. In the preferred embodiment the lateral shift is equal and opposite to that used in the left eye. For example, should layer 2 be shifted to the left by –2 mm then for the right eye a shift of +2 mm would be used. It

should be appreciated that the unit of shift measurement will relate to the medium the 2D image is represented in and may include, although not limited to, pixels, percentage of image size, percentage of screen size etc.

A composite image is then created from the separate layers so as to form separate left and right eye images that may subsequently be viewed as a stereo pair. This is illustrated in Figure 3.

In the preceding explanation it will be appreciated that the original layered image may be used to create one eye view as an alternative to making a copy.

It will be understood by those skilled in the art that this technique could be applied to a sequence of images and for explanation purposes only a single 2D image has been illustrated.

It will also be understood by those skilled in the art that the objects in the original 2D image may be described in other than visible images, for example vector based representations of objects. It is a specific objective of this invention that it be applicable to all image formats that are composed of layers. This includes, but is not limited to, cartoons, vector based images i.e. Macromedia Flash, MPEG encoded images (in particular MPEG 4 and MPEG 7 format images) and sprite based images.

ENCODING AND COMPRESSION

As we have disclosed previously there is significant redundancy in the allocation of depth to objects. For example, should an object appear at the same x,y co-ordinates and at the same depth in subsequent image frames then it is only necessary to record or transmit this information for the first appearance of the object.

Those skilled in the art will be familiar with techniques to encode and compress redundant data of this nature.

ALTERNATIVE EMBODIMENTS

It will be appreciated that the lateral displacement technique can only be applied where objects on underlying layers are fully described. Where this is not the case, for example where the 2D image did not originally exist in layered form but was converted into separate layers using image segmentation techniques,

then the previously disclosed DDC stretching techniques can be applied to create the stereoscopic images.

It will also be appreciated that by simply laterally shifting objects the resulting 3D image will contain objects that appear to be flat or have a "cardboard cutout" characteristic. By applying our previously disclosed DDC techniques it is intended that the 3D effect may be enhanced. For example, an object may have a depth characteristic that combines a lateral shift and a depth ramp. The resulting object would therefore be both laterally displaced and stretched as disclosed in PCT/AU96/00820.

Where objects do exist in a layered from, and are partially or fully described, the DDC technique is not required to identify and outline objects since this has already been undertaken. However, the allocation of depth characteristics is still required.

It will be known to those skilled in the art that stereoscopic displays are emerging that do not rely on left eye and right eye images as a basis of their operation. It is the intention of this invention that the techniques described may be employed by existing and future display technologies.

For example, displays are emerging that require a 2D image plus an associated depth map. In this case the 2D image of each object may be converted into a depth map by applying the depth characteristics identifier previously described to each object.

The individual layers then being superimposed to form a single image that represents the depth map for the associated 2D image. It will be appreciated by those skilled in the art that this process can be applied either prior to displaying the stereoscopic images or in real time.

In addition, another display type is emerging that requires more images than simply a stereo pair. For example, the autostereoscopic LCD display manufactured by Phillips requires 7 or 9 discrete images where each adjacent image pairs comprise a stereo pair. It will be appreciated that the lateral displacement technique described above may also be used to create multiple stereo pairs suitable for such displays. For example, to create an image sequence suitable for an autostereoscopic display requiring 7 views the original

2D image would be used for the central view 4 and views 1 to 3 obtained by successive lateral shifts to the left. Views 5 to 7 would be formed from successive lateral shifts to the right. This process would be familiar to those skilled in the art of producing 3D images from multiple 2D images mounted under a lenticular lens.

As we have previously disclosed, the depth characteristics may be included in the definition of the original 2D image thus creating a 2D compatible 3D image. Given the small size of this data, 2D compatibility is obtained with minimal overhead.

We have also previously disclosed that the depth characteristics can be included in the original 2D images or stored or transmitted separately.

DATED this 4th day of August 2000

DYNAMIC DIGITAL DEPTH RESEARCH PTY LTD

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Figure 1

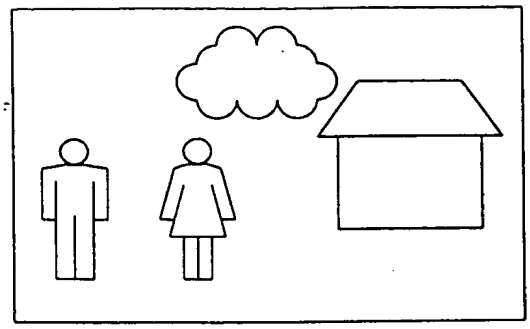
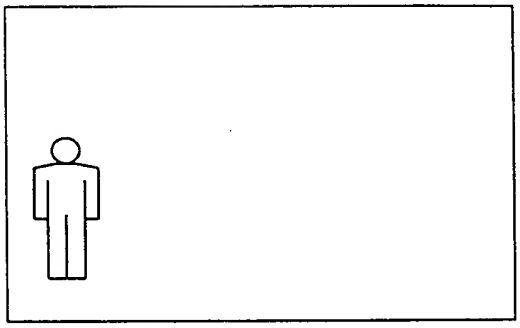
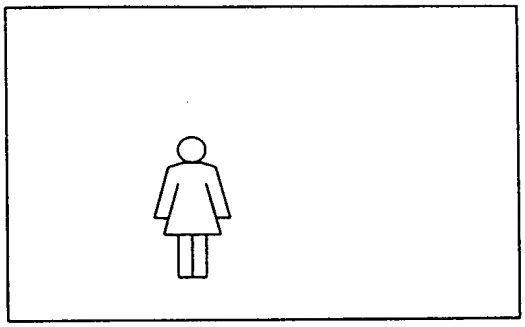


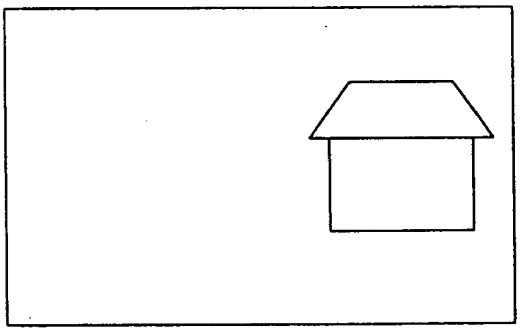
Figure 2



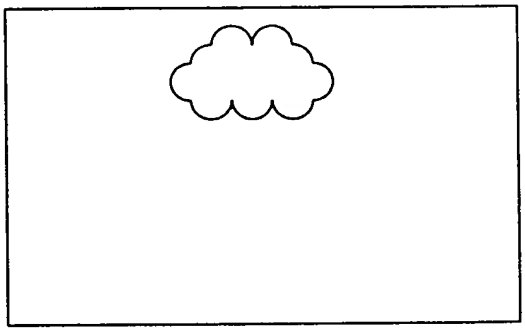
Layer 1



Layer 2

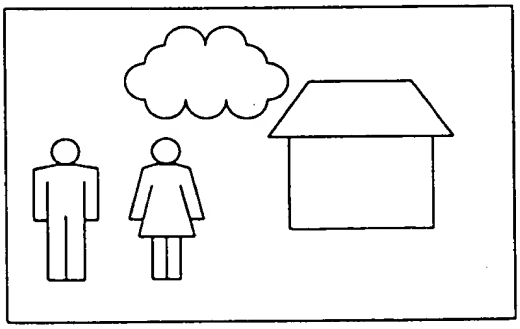


Layer 3

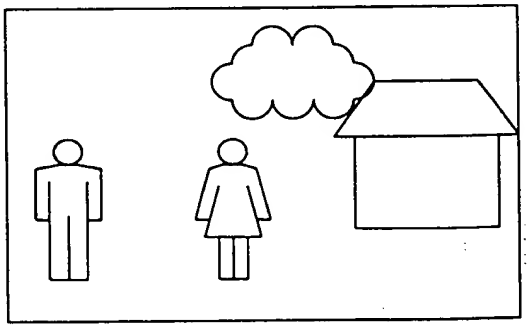


Layer 4

Figure 3



Left Eye Image



Right Eye Image